

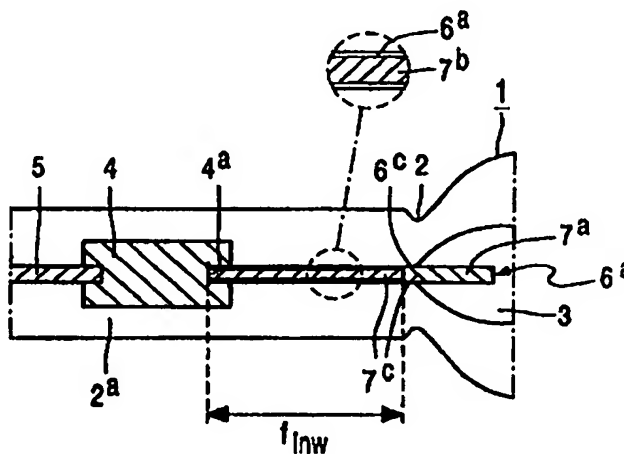
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/IB99/01038 <b>(22) International Filing Date:</b> 7 June 1999 (07.06.99)  <b>(30) Priority Data:</b> 98202197.4      30 June 1998 (30.06.98)      EP  <b>(71) Applicant:</b> KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).  <b>(71) Applicant (for SE only):</b> PHILIPS AB [SE/SE]; Kottbygatan 7, Kista, S-164 85 Stockholm (SE).  <b>(72) Inventors:</b> EIJSERMANS, Joseph, F., R.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). SEEBODE, Dorothea; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). JORRES, Angela; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).  <b>(74) Agent:</b> ROLFES, Johannes, G., A.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).	<b>(81) Designated States:</b> CN, JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i>	

**(54) Title:** HIGH-PRESSURE GAS DISCHARGE LAMP**(57) Abstract**

The high-pressure discharge lamp comprises a sealed lamp vessel (1) having a quartz glass wall (2) enclosing a discharge space (3). Metal foils (4) are embedded in the wall, connected to electrode rods (6a) projecting from the wall into the discharge space. The electrode rods (6a) have a first part (7a) and a second part (7b). The second part is either at least substantially made of tungsten with a diameter of 120 to 180  $\mu\text{m}$  or molybdenum with a diameter of 120 to 350  $\mu\text{m}$ , or tungsten-molybdenum mixtures with a diameter of 120 to 350  $\mu\text{m}$ . The second part, which is positioned within the wall (2), prevents premature failure of the lamp caused by leakage.



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High-pressure gas discharge lamp.

The invention relates to a high-pressure gas discharge lamp comprising:

a lamp vessel which is closed in a vacuumtight manner and has a quartz glass wall enclosing a discharge space;

metal foils embedded in the wall of the lamp vessel and each connected to a  
5 respective external current conductor;

tungsten electrode rods each connected to a respective one of said metal foils and projecting from the wall of the lamp vessel into the discharge space;

an ionizable filling in the discharge space;

the lamp being defined by the following relation

10  $f_{\text{inw}} \geq 40\%$

in which:

$f_{\text{inw}}$  = fraction of length of the electrode rod enclosed in the wall of the lamp vessel.

15 A high-pressure gas discharge lamp of this type is known from EP 0 581 354-A1. The known lamp is suitable for use as a vehicle headlamp and has electrode rods of a thickness of 250  $\mu\text{m}$  which may or may not have an envelope at their free ends and may be made of, for example, thoriated tungsten.

Stringent requirements are imposed on the speed with which the lamp, after it  
20 has been ignited, provides a large fraction of the luminous flux during stable operation. It is also necessary that the lamp can be ignited while it is still hot due to a previous operating period. The lamp is ignited at a voltage of several kV and a frequency of several kHz in order to comply with these requirements.

In the manufacture of the known lamp, a seal is made in which one or several of  
25 said metal foils are enclosed in the wall. During this operation, the quartz glass is softened at the area where this seal is to be created in the presence of the metal foil, the external current conductor and the electrode rod. Subsequently, the lamp, or the lamp-to-be, cools down. Due to its relatively high coefficient of linear thermal expansion (approximately  $45 \cdot 10^{-7} \text{ K}^{-1}$ ), the electrode rod then contracts more strongly than the quartz glass in which it is embedded.

Quartz glass is a glass having an  $\text{SiO}_2$  content of at least 98% by weight, the coefficient of expansion of the glass is approximately  $6 \cdot 10^{-7} \text{ K}^{-1}$ . For a good adhesion between the rod and the quartz glass, obtained by an additive to the electrode rod tungsten, such as thorium oxide, a coating of quartz glass around the rod is obtained, which is mechanically unconnected with the quartz glass of the wall. If the electrode rod and the quartz glass adhere insufficiently to each other, a capillary space is created due to shrinkage around this rod. No such capillary space is created around the metal foil, often a molybdenum foil, because of the foil shape.

In the known lamp, there is often a good adhesion between the rod and the quartz glass and thus there is a coating of quartz glass around the rod. The quartz glass coating of the electrode rods in the known lamp enhances their thermal capacity (the energy which is necessary for the same rise of temperature) and also increases their thermal conductance (the quantity of heat which can be depleted per unit of time). On the other hand, their electrical conductivity is not affected. The higher thermal capacity retards the rise of temperature of the rods during ignition of the lamp, so that the permanent contact with the embedded metal foil enables the surrounding quartz glass of the wall to assume a higher temperature and to expand, also because of the heat developed in this foil due to the passage of current.

It has been found that the coatings of species of one type of lamp may have alternating lengths. This may be due to small variations of temperature of the quartz glass when the seal is being made. It is a drawback that the absence of a coating or an insufficient coating results in rejects during the lamp production and that the known lamp has only a short lifetime when there is no or not enough quartz glass coating and when this lamp is often switched on and switched off after a short operating period.

When such a lamp without coating is ignited, the temperature of the electrode rods rises steeply owing to the high current flowing through them and owing to heat transfer from the discharge. The quartz glass does not instantaneously follow this temperature rise. Owing to their higher temperature and their higher coefficient of expansion, the rods will come into contact with the quartz glass and exert pressure on it. It was found that damage, such as microcracks, then occurred in the quartz glass, which microcracks generally increase in number and size during subsequent ignition periods. This leads to a (premature) end of the lifetime of the lamp owing to leakage, causing constituents of the filling to escape so that the lamp no longer ignites, or the lamp vessel is broken.

Lamps complying with the relation  $f_{\text{inw}} \geq 40\%$  have a greater risk of occurrence of the above-mentioned detrimental phenomena, unless special circumstances are created, for example, a quartz glass coating around the electrode rod.

Another drawback is that the coating leads to unwanted and troublesome reflections of the light generated in the discharge.

5 It is an object of the invention to provide a high-pressure gas discharge lamp of the type described in the opening paragraph, having a simple construction and counteracting said drawbacks.

According to the invention, this object is achieved in that the electrode rods have first parts projecting into the discharge space, which first parts are at least substantially made of tungsten, and second parts enclosed at least partly in the wall, which second parts are made of elements chosen from the group of tungsten having a thickness ranging between 120  $\mu\text{m}$  and 180  $\mu\text{m}$ , molybdenum having a thickness ranging between 120  $\mu\text{m}$  and 350  $\mu\text{m}$  and tungsten-molybdenum alloys having a thickness ranging between 120  $\mu\text{m}$  and 350  $\mu\text{m}$ , said first and second parts contacting and being connected to each other via facing ends.

15 Since the electrodes are composed of a first and a second part, it is possible to adapt the electrodes to the circumstances. The first part is made in conformity with the end of the electrode of the known lamp projecting into the discharge space, so that, during its lifetime, it can withstand the heat developed by the high starting currents and the discharge. The second part is designed in such a way that the problem of leakage or breakage of the lamp owing to expansion and, consequently, exertion of pressure on the quartz glass by the second part of the electrode rod during (re)ignition of the lamp at least substantially does not occur anymore.

It has been found that in lamps complying with the relation  $f_{\text{inw}} \geq 40\%$ , the occurring problems of leakage at least substantially do not occur in electrode rods having relatively small thicknesses of the second parts enclosed in the wall. In lamps having electrode rods with second parts of tungsten having a thickness of 180  $\mu\text{m}$ , it was found that leakage of the lamp only occurred sporadically. At thicknesses of less than 180  $\mu\text{m}$ , the absolute value of the expansion, and hence the pressure exerted by the electrode rods on the quartz glass, is so small that any further damage, such as microcracks, no longer occurs.

30 In lamps having electrode rods with second parts of both tungsten-molybdenum alloys and molybdenum having a thickness of 350  $\mu\text{m}$ , it was found that leakage of the lamp only occurred sporadically. The risk of leakage or breakage of the lamp is considerably reduced if the thickness of these second parts is chosen to be smaller than 350  $\mu\text{m}$ . The successful use of relatively large thicknesses with second parts of molybdenum or tungsten-

molybdenum alloys is based on the ductility of these materials. When exerting pressure on the quartz glass, due to expansion by the electrodes, this pressure will be more evenly distributed due to deformation of the relatively ductile material than when using electrodes which are made of, for example, the much less ductile tungsten.

5                   However, for second parts made of both tungsten, tungsten-molybdenum alloys and molybdenum having thicknesses of less than 120  $\mu\text{m}$ , the electrodes only have such a small thermal capacity due to their slight mass and also only a small thermal conductance due to their relatively small diameter that the electrode consequently becomes relatively hot during starting of the lamp. Although small capillary spaces have formed during embedding in the  
10 quartz glass due to the relatively small thicknesses of the second parts, it was found that under the given circumstances the electrode rod in these capillary spaces locally made permanent contact with the wall of the lamp vessel so that the depletion of heat was enhanced in such a way that it adequately compensated the small thermal conductance of the electrode resulting from its relatively small diameter, so that a premature end of the lifetime of the lamp was  
15 prevented.

                  It was found that electrodes having a second part with a thickness of less than 120  $\mu\text{m}$ , for example 100  $\mu\text{m}$ , became too hot and appeared to be deformed and/or melt during lamp operation. Due to the fact that the electrode melts, the length of the discharge arc between the electrodes changes and, consequently, the power consumption during nominal  
20 operation of the lamp also changes.

                  An important advantage of the measure according to the invention is that it provides the possibility of using thorium-free material for the electrode rods without detrimentally influencing the lifetime of the lamp. The capillary spaces which have formed during embedding of the electrode rod in the quartz glass are relatively small in second parts  
25 having thicknesses of less than 350  $\mu\text{m}$ . Therefore, this has the additional advantage that no large quantities of salts can accumulate in these capillary spaces, which salts would otherwise have been extracted from the discharge.

                  The first and the second part of the electrode may be secured to each other by means of conventional techniques, for example laser welding. It is important that a good  
30 contact is realized when the first and the second part are secured to each other via the ends of the electrode rods. This is essential for a satisfactory transfer of heat from the first to the second part and it contributes to the fact that the electrode can withstand the heat developed by the high starting currents and the discharge during the lifetime of the lamp.

It is favorable when both the first and the second part is made of tungsten. The first and second parts can then be made by means of etching techniques, for example, pickling, from one piece.

Due to the relatively small thickness of the second part, it is favorable for a robust construction, i.e. to avoid deformation of the electrode, that the first part proximate to its connection with the second part is in permanent contact with the wall of the lamp vessel, for example, partly enclosed in the vessel, for example over a length of 0.1-1.0 mm. The permanent contact with the wall of the lamp vessel of the first parts, proximate to their connection with the second parts, is also favorable for a satisfactory depletion of heat of the composite electrode.

Due to the high starting currents upon ignition of the lamp and the heat developed as a result of the discharge, not only relatively high temperatures occur in the second parts but also in the first parts of the electrodes. In first parts having a thickness of less than 250  $\mu\text{m}$ , there is a relatively great risk of melting of the electrode head. Electrodes having first parts with a thickness of more than 250  $\mu\text{m}$  have a sufficient thermal conductance so that the risk of melting is reduced quite considerably. Moreover, the first parts preferably have a thickness of less than 400  $\mu\text{m}$ . Then there is hardly any risk that the unfavorable effect of lamp flickering will occur, i.e. the point of contact of the discharge arc jumps over the head of the electrode.

The high-pressure gas discharge lamp according to the invention may be used, for example, as a vehicle headlamp, or in an optical system of a different kind. For this purpose, the lamp may be provided with a lamp cap and may or may not be surrounded by an outer envelope. A lamp cap may or may not be integrated with a reflector.

The lengths of the first and second parts are also determined by the total length of the entire electrode. In a favorable embodiment, the entire electrode has a length of between 4,5 and 7,5 mm, preferably 6 mm. The choice of the length of the separate parts is such that the connection of the first part to the second part is at least substantially located at the boundary surface of the wall and the discharge space, at the location where the electrode projects into the discharge space.

The metal foils may be embedded next to one another in one region of the wall, or in regions situated at a distance from one another, for example, opposite one another. The first parts of the electrode rods may or may not have an enveloping winding at their free ends in the discharge space. The first parts of the electrode rods may be made of undoped tungsten, for example tungsten-ZG, or of doped tungsten such as W with 1.5% by weight of Th. The

second parts of the electrode rods may be made of undoped tungsten or molybdenum, for example tungsten-ZG, of tungsten-molybdenum mixtures or of doped tungsten or molybdenum such as Mo with 3% by weight of Y. When doped tungsten is used, a small content of crystal growth-regulating means such as 0.01% by weight in total of K, Al and Si may be added so as to influence the tungsten grain size.

The ionizable filling may comprise, inter alia, a rare gas, mercury and a mixture of metal halides, for example, rare-earth halides which are the halides of the lanthanides, scandium and yttrium.

These and other aspects of the invention are apparent from and will be elucidated, by way of non-limitative example, with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a lamp in a side elevation;

Figs. 2A and 2B show a detail of Fig. 1 on an enlarged scale;

Fig. 3 shows the lamp of Fig. 1 with a lamp cap in a side elevation.

In Fig. 1, the high-pressure gas discharge lamp has a lamp vessel 1 which is closed in a vacuumtight manner and a quartz glass wall 2 enclosing a discharge space 3. Metal foils 4, Mo with 0.5% by weight of  $Y_2O_3$  in the Figure, each connected to respective external current conductors 5, of Mo in this embodiment, are embedded in the wall of the lamp vessel. Tungsten electrode rods 6a each connected to a respective one of said metal foils 4 project from the wall of the lamp vessel into the discharge space.

An ionizable filling is present in the discharge space 3.

Connected to the metal foils 4 with the external conductors 5 secured thereto, the electrode rods 6a are partly enclosed in the wall of the lamp vessel, and the wall is fused with the conductors at the area of these conductors, or the wall has been flattened so as to realize a pinched seal.

In the Figure, the lamp vessel is surrounded by an outer envelope 9 and coupled thereto. The lamp may be gripped by a lamp cap at a metal clamping sleeve 10.

The lamp described has a filling of mercury, sodium iodide and scandium iodide, and xenon, for example, xenon at a pressure of 7 bar at room temperature, and consumes a power of 35 W during operation at rated voltage.



Figs. 2A and 2B show that the entire electrode rods 6a are enclosed in the wall 2 of the lamp vessel 1 over a fraction of length  $f_{inw}$  of approximately 75%, so that the lamp complies with the relation  $f_{inw} \geq 40\%$ . The electrode rods 6a each having a length of approximately 6 mm each have a first part 7a and a second part 7b with a length of approximately 1,5 mm and approximately 4,5 mm, respectively, which are adjacent and connected to each other, for example, by means of a weld via the ends 7c of the first and the second part. The ends 7c are located near the wall 2 of the lamp vessel 1. The first part 7a is in permanent contact with the wall 2 of the lamp vessel 1 at contact area 6c, however, without a risk of leakage or breakage of the lamp. The electrode rods 6a each have the second part 7b in the wall 2, at least proximate to the relevant metal foil 4, which second part is mechanically unconnected with the glass of the wall.

In the embodiment shown in Fig. 2A, the electrode rod 6a has a first part 7a made of tungsten with a thickness of 300  $\mu\text{m}$ , and a second part 7b made of tungsten with a thickness of 150  $\mu\text{m}$ . In the embodiment shown in Fig. 2B, the electrode rod 6a has a first part 7a made of tungsten with a thickness of 300  $\mu\text{m}$ , and a second part 7b made of molybdenum with a thickness of 300  $\mu\text{m}$ . The Figure shows that the second part 7b and the capillary 6b around it terminate at the weld 4a of the rod on the foil. The seal 2a is vacuumtight in an area between the external current conductor 5 and the electrode rod 6a.

In Fig. 3, the lamp vessel 1 is enclosed in a different outer envelope 9a and coupled thereto. The lamp vessel is fixed in a lamp cap 8 of the bayonet type, provided with a central pin contact 11 and a ring contact 12 which are connected to respective electrode rods 6a, the ring contact via a connection conductor 13. The lamp vessel 1 provided with such a lamp cap 8 is eminently suitable as a vehicle headlamp.

## CLAIMS:

1. A high-pressure gas discharge lamp comprising:  
a lamp vessel (1) which is closed in vacuumtight manner and has a quartz glass wall (2) enclosing a discharge space (3);  
metal foils (4) embedded in the wall of the lamp vessel and each connected to a  
5 respective external current conductor (5);  
tungsten electrode rods (6a) each connected to a respective one of said metal foils and projecting from the wall of the lamp vessel into the discharge space;  
an ionizable filling in the discharge space;  
the lamp being defined by the following relation,  
10  $f_{inw} \geq 40\%$   
in which:  
 $f_{inw}$  = fraction of length of the electrode rod enclosed in the wall of the lamp vessel,  
characterized in that the electrode rods (6a) have first parts (7a) projecting into  
15 the discharge space (3), which first parts are at least substantially made of tungsten, and second parts (7b) at least partly enclosed in the wall (2), which second parts are made of elements chosen from the group of tungsten having a thickness ranging between 120  $\mu\text{m}$  and 180  $\mu\text{m}$ , molybdenum having a thickness ranging between 120  $\mu\text{m}$  and 350  $\mu\text{m}$  and tungsten-molybdenum alloys having a thickness ranging between 120  $\mu\text{m}$  and 350  $\mu\text{m}$ , said first and  
20 second parts contacting and being connected to each other via facing ends (7c).
2. A high-pressure gas discharge lamp as claimed in claim 1, characterized in that the first parts (7a) of the electrode rods (6a) are in permanent contact with the wall (2) of the lamp vessel (1) at a contact area (6c).
- 25 3. A high-pressure gas discharge lamp as claimed in claim 1 or 2, characterized in that the first parts (7a) of the electrode rods (6a) have a thickness of 250  $\mu\text{m}$  to 400  $\mu\text{m}$ .

4. A high-pressure gas discharge lamp as claimed in claim 1, 2 or 3, characterized in that the electrode rods (6a) have a length of between 4,5 mm and 7,5 mm.

5. A high-pressure gas discharge lamp as claimed in claim 1, 2, 3 or 4,  
5 characterized in that the lamp is provided with a lamp cap (8).

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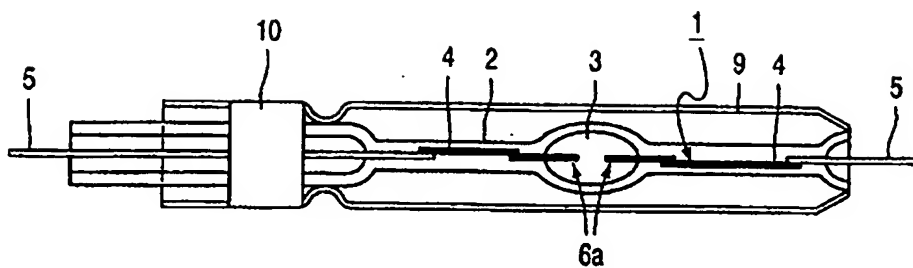


FIG. 1

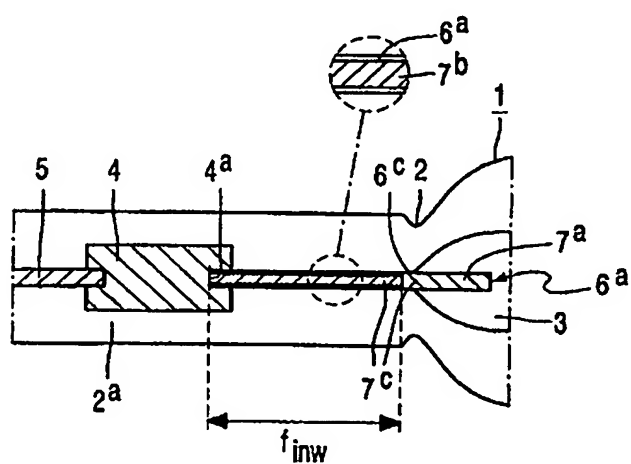


FIG. 2A

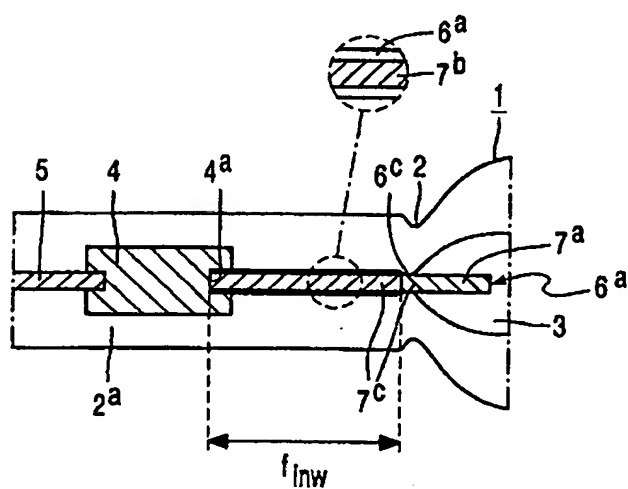


FIG. 2B

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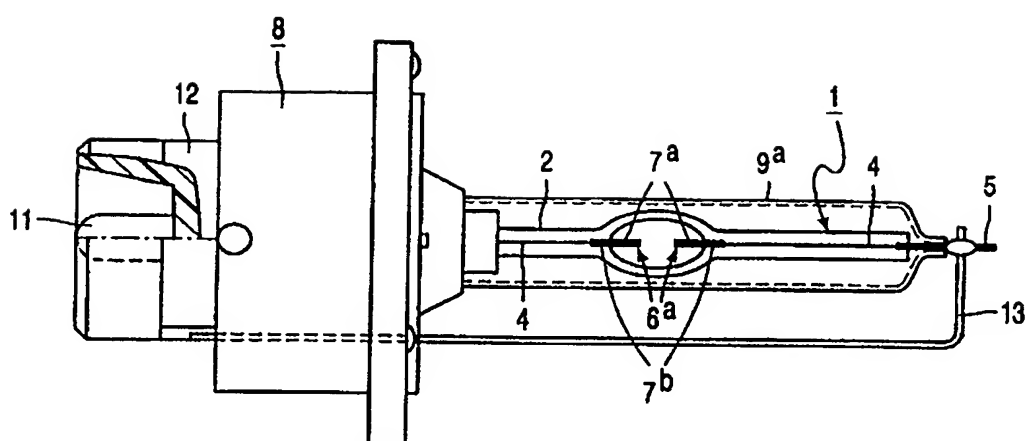


FIG. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 99/01038

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01J 61/073 // H01J 61/36

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0581354 A1 (PHILIPS ELECTRONICS N.V.), 2 February 1994 (02.02.94), column 7, line 17 - line 24; column 7, line 41 - line 47, figures 2,3 --	1-5
Y	EP 0609477 A1 (PATENT.TREUHAND-GESELLSCHAFT FÜR ELEKTRISCHE GLÜHLAMPEN MBH), 10 August 1994 (10.08.94), column 10, line 6 - line 16; column 10, line 42 - line 48; column 13, line 16 - line 23 --	1-5
Y	DE 3536553 C1 (W.C. HERAEUS GMBH), 13 November 1986 (13.11.86), figures 1b,1c, claims 1-4 --	1-5

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## INTERNATIONAL SEARCH REPORT

International application No.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19603301 A1 (PATENT-TREUHAND-GESELLSCHAFT FÜR ELEKTRISCHE GLÜHLAMPEN MBH), 31 July 1997 (31.07.97)  --	1
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P,A	US 5905340 A (R.J. KARLOTSKI ET AL), 18 May 1999 (18.05.99), figures 3,4  -- -----	1

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/08/99

International application No.  
PCT/IB 99/01038

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